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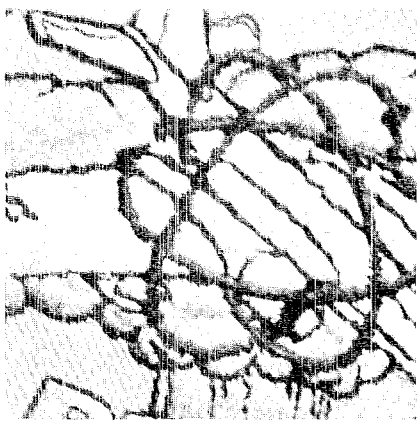
ON THE COVER:

Curious to the sight is a special colony of nude mice at the Life Sciences (LS) Division laboratories. Here, photographer Bill Jack Rodgers contrasts the normal pink nude mouse with a dyed blue nude; the normal white haired mouse is at the bottom. Story and more photos follow inside.

Preview:

They live in a special room, eat autoclaved food, and are carefully attended. The attention given to this special colony of nude, blue mice arises from their importance to carcinogen research at the Laboratory. Eventually, researchers may be able to work more with cell cultures only for tumor analysis, and not the animals themselves...

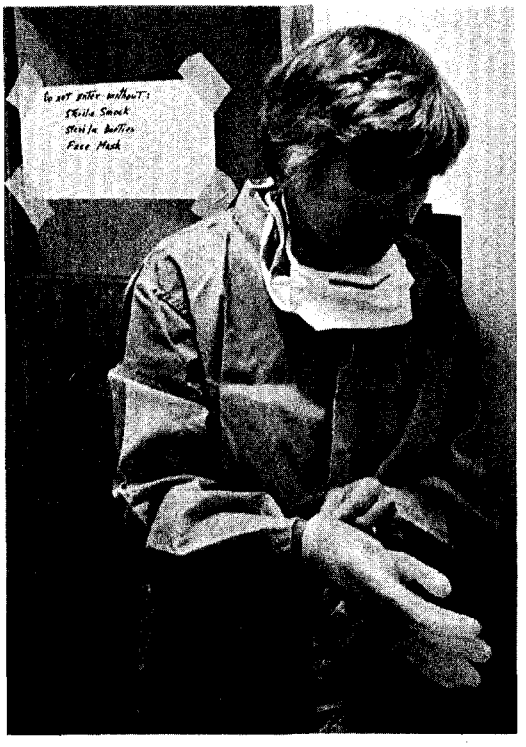


The special aircraft called the RB-57F was redesigned to conduct air sampling missions over 10 years in conjunction with LASL's nuclear testing program. Now disbanded, the 58th Squadron made other scientific studies as well, through all of the world's hemispheres. Part of their history is recalled in a story inside...

Near a half-mile-long accelerator, just away from the parking lot of the new AT-Division office building, lies a centuries-old kiva built by the Pajarito Plateau inhabitants. It has been excavated again, but in a less painstaking manner than the first time around...

The normal nude mouse is pink before a harmless trypan blue dye is introduced into the animal. The nudes, a special colony that started with one naturally occurring mutant, are important in malignancy tests.

Photos by Bill Jack Rodgers



Mary Brooks checks the mouse colony daily and records any changes in pregnant or sick rodents. First, she must don sterile mask, gown, gloves, and footwear.

Search for better malignancy tests

By Jeff Pederson

A special colony of mice at the Life Sciences (LS) Division would be of interest for the members' physical characteristics only — the animals are nude (without fur) and some are literally blue in color.

There is, however, an importance to medical research conducted at the Health Research Laboratory that transcends these distinctions. The mice are part of a years-long task to determine the validity of malignancy tests on cells, both in living organisms (*in vivo*, or in life) and in artificial environments (*in vitro*, or literally in glass).

The most important objective of the project, said Paul Kraemer, principal investigator and Experimental Pathology group leader at LS-4, is to develop an improved way to determine whether cells treated with suspected carcinogens have become malignant.

Scientists understand there is a relationship between cancer-causing carcinogens and mutation-causing agents. But the relationship remains unresolved in the research community, underscoring the need to propose efficient ways to detect carcinogens. The commonly used methods to analyze malignancy *in vitro* have not proven accurate for predicting malignant behavior of cells tested in animals.

In cancer research, it could be more expedient to work only with cell transformations, and not with animals themselves, if the cell experiments gave a true reflection of what would later happen in the body.

Enter the nude, blue mice.

Characteristics of the nude mouse

Nude mice first attracted notice because they lacked a fur coat. The first nude mouse, a genetic mutation, appeared in a line of outbred mice that carried other serious genetic defects. It was later discovered, 11 years ago, that the nude also lacks a normal thymus gland. By a series of crosses, the mutation was introduced into other mouse strains.

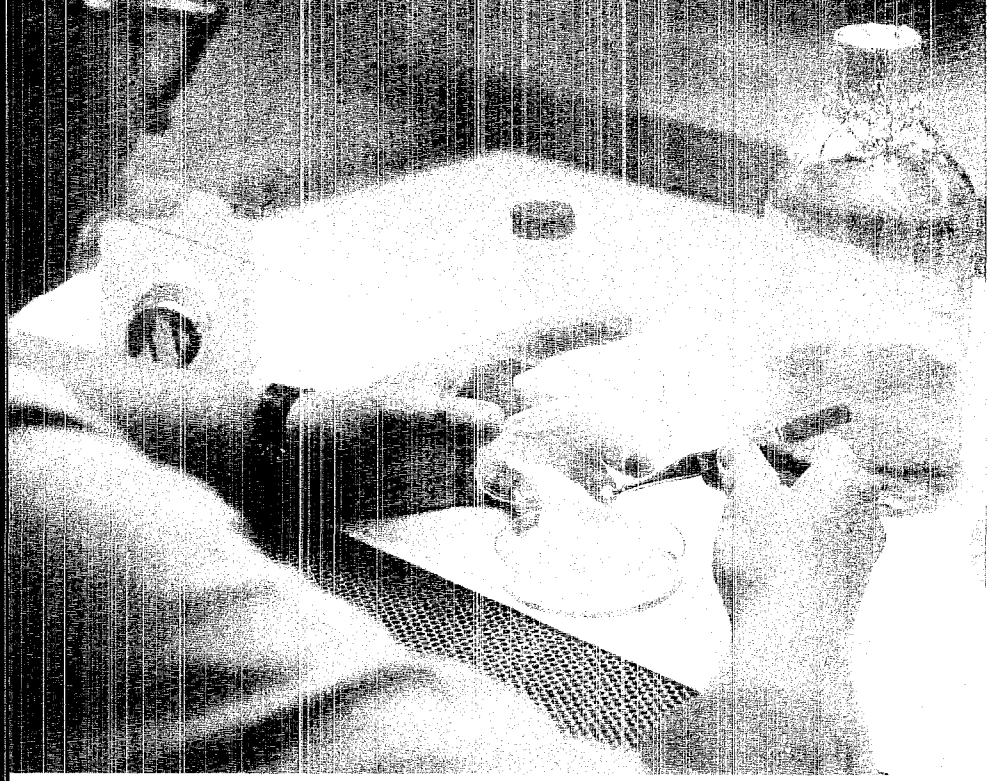
Several mutant genes in mice can produce a hairless offspring; the term nude should not be swapped with the terms naked, hairless, or rhino, which each describe a different gene pool. Only the nude is known to lack the thymus gland. Since this gland is responsible for the type of immunity associated with rejection of grafts, it is this feature that accounts for the importance of nude mice in cancer research.

"We received 5 breeding pairs in January 1978," said Marty Holland, alternate group leader of

Principal investigator Paul Kraemer works with an incubator in the Health Research Laboratory, in a suite once used for cobalt-60 tests.

In the lab, Mary Brooks examines a filtered cage holding a group of nude mice.

The first nude mouse was a mutant that lacked a normal thymus gland. The Life Science Division received 5 breeding pairs nearly a year ago and now has produced more than 1,000 mice from them.



A sponge technique is used to transplant tumors under the skins of the mice, as Paul Kraemer here demonstrates.

Toxicology (LS-1), and the man in overall charge of animal research at the Health Research Laboratory. "Of the 5, half were nudes and half were not. We now have produced more than 1,000 mice from these, and some of the original pairs are still alive and have produced up to 13 litters for us."

In breeding, the nude male is used with a female that carries just half of the nude mutation; she has a thymus gland and fur, because the nude gene is recessive. About half of the resulting litter will be nude, and half will not. The difference is apparent when the mice are young and naturally pink in color — the blue is later added as a harmless dye. The pure nude female doesn't perform well as a mother, as a general rule, being less hardy and experiencing more difficulties with pregnancy than the half-nude female. The nude male, in contrast, is fertile and active.

Special care

The problem with nude mice is that they will live only for about 2 to 4 months in the standard research environment. This is because the graft rejection type of immunity is also related to resistance to some infections. But the same lack of a thymus gland makes the rodents valuable for research, since they tend not to reject implanted tumors, even if the tumors are derived from other species, including human.

Normal lifetimes have been achieved for the nude colony at LASL by using the most careful methods of husbandry. The first shipment of animals came from a Madison, Wisconsin supplier in

Bob Wells and Marty Holland, each wearing the required sterile gear, examine one of the blue mice for signs of tumor growth.

"Since the mice lack thymus glands and also are blue, they tend to accept implants such as skin grafts and tumors much more readily than normal laboratory mice."

special, sterile, filtered cages. The resulting colony has grown in a protected environment in the laboratory, where any infection from the other 8,000 rodents in the building could conceivably wipe out the nude mice. They live in sterilized cages with filters, they have a positive-pressure room that tends to prohibit foreign airborne substances from entering, and their food and water supplies are autoclaved.

Staff member Mary Brooks, who has the primary day-to-day responsibility for the colony's well-being, dons sterile gown, face mask, and shoe coverings before entering the room, which is maintained at 80 degrees F. She checks the colony daily and notes the condition of any pregnant animals. She logs births, sicknesses, and any other changes in physical condition or behavior.

"Once in a while there is a death other than from experimental tumors or old age, but it is rare," said Brooks.

Checks are run periodically to determine whether any foreign agents or disease-causing elements are present in the room, which once was used as a cobalt-60 experimental suite. "The colony is totally uncontaminated," said Holland. "Other colonies elsewhere have been wiped out by disease, sometimes suddenly. This would be catastrophic because it would wipe out all experiments in progress as well."

The LASL success with the colony's health bodes well for the experimental project; there is only a handful of such nude mice colonies in the United States, after all.

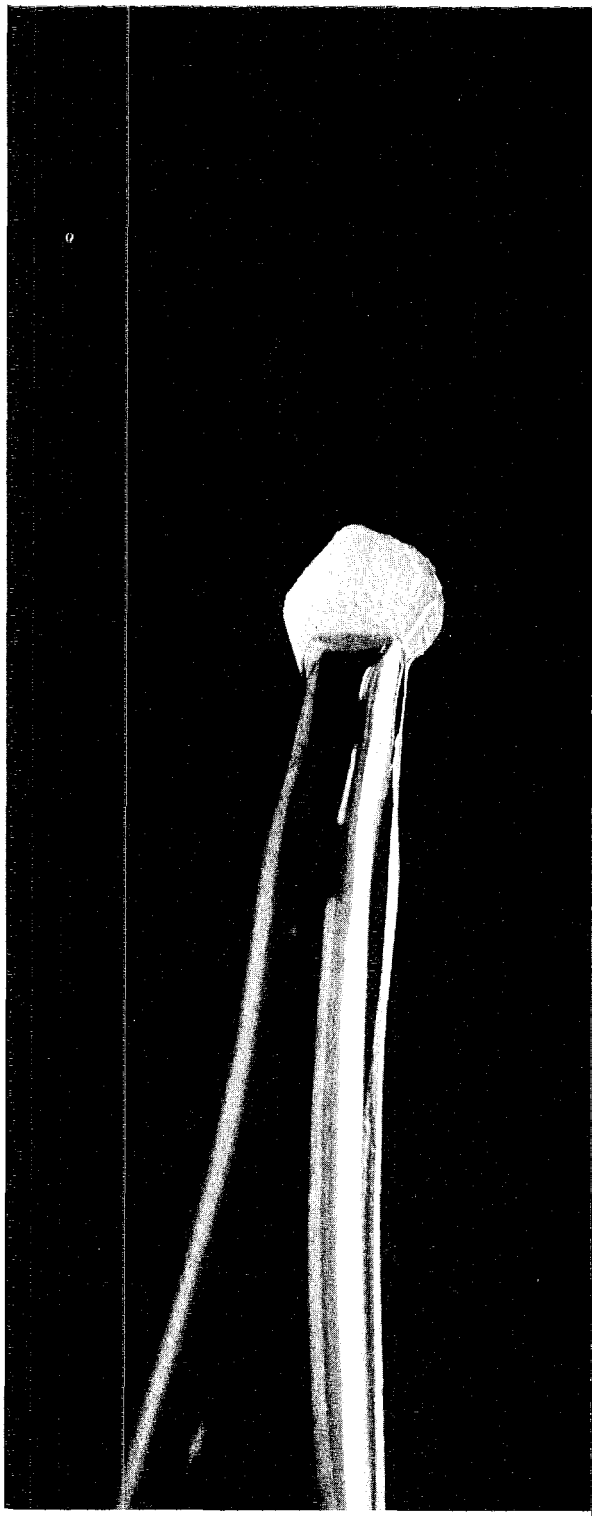
"For a long time, it was not known that nude mice could have a normal 24-month life span," Kraemer noted. "People tried to squeeze experiments into the 2-month life span. The question then became, how do you interpret tumor growth in mice that were dying anyway?"

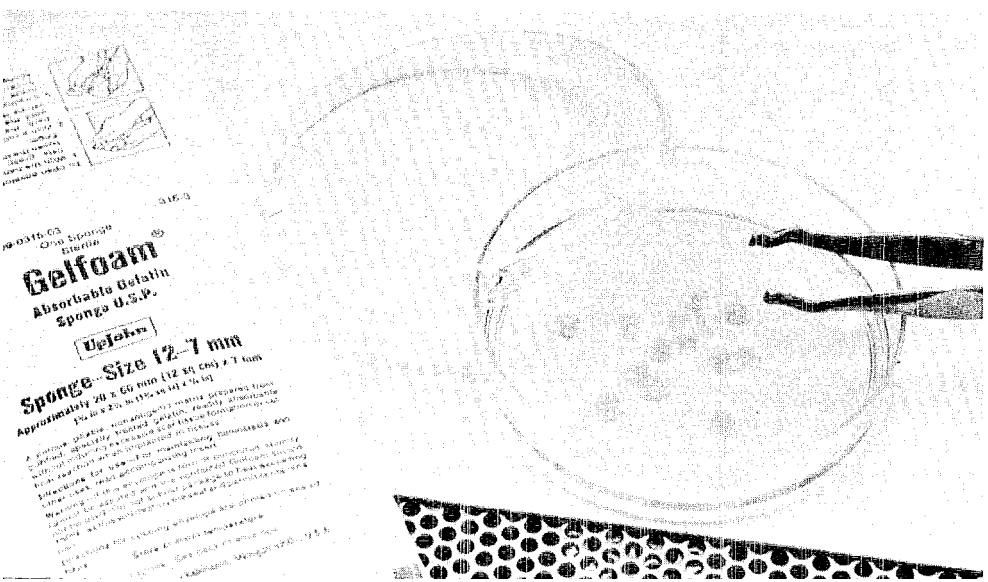
Why the blue?

The nude mice are normally pink in color, yet part of the LASL colony is blue. That's because a special dye, trypan blue, is introduced into the rodents. It produces an even color throughout, so the internal organs, and implanted tumors, are also blue.

"The mice are entirely unharmed and indifferent to the dye," said Holland. "There is no indication of any discomfort."

The importance of the trypan blue lies in its attribute of additionally blocking another host defense system. This allows a





A gelatin sponge culture, in detail, from lab dish to tweezers.

Infection or disease could conceivably wipe out the colony, so the mice are kept in a sterile environment, and live to normal ages.

further test, or assay, of tumor rejection. The blue dye engages the mouse's macrophages, or amoeba-like cells, in a diversionary tactic.

Macrophages, part of a primitive defense mechanism, will attack certain tumor cells and foreign particles. The trypan blue dye consists of small particles. According to theory, the macrophages are engorged with the trypan blue dye and are too sated to attack tumor cells in the mice.

"Our work is with designing systems to test the capacity of cells to form tumors," said Kraemer. "Since the mice lack thymus glands and also are blue, they tend to accept implants such as skin grafts and tumors much more readily than normal laboratory mice. Without such a system, there is often no way to prove that cells are malignant, even if they are directly derived from a fatal cancer case."

"Whatever tests we may come up with must be reliable. If the cells form tumors in blue nudes, but not in standard nude mice, that would be a good indicator of macrophage participation in tumor defense," said Robert Wells, post-doctoral fellow and pathologist. "We are looking for better tests, or as we say, tumorgenicity assays."

Laboratory approach

Detecting carcinogens by their effects on cultured cells may depend on the ability to detect cancer cells at an early stage, cells that are not transformed according to *in vitro* parameters now commonly used (such as the ability of cells to grow suspended, in a semi-solid medium). Researchers have also demonstrated the need for more reliable ways to test cell culture systems. The LASL experiments aim at both problems.

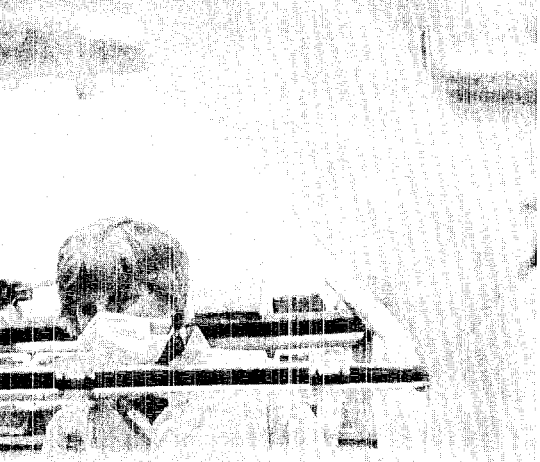
Conventional *in vitro* cell transformation techniques are being combined with special methods to follow the performance of cells implanted in nude mice. Two cell types, one widely used already and one established from the LASL nude mouse colony, are being employed.

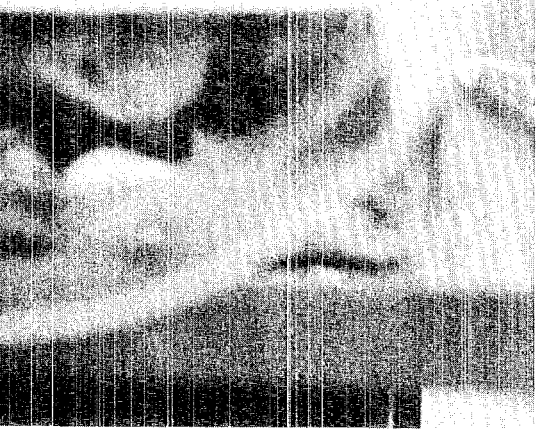
The "normal" cell line, Balb/c 3T3, is grown in foam sponge disks about 6 millimeters in diameter by 7 millimeters thick. They are implanted in nude mice and left over an extended time period. Using sponge cultures, tumors result, but progressive tumors appeared only after a prolonged dormant stage. Since these cells are commonly used as "normal" for carcinogen testing, the LASL experiments raise serious questions concerning the validity of the conventional methods.

An important problem is the fact that cultured rodent cells invariably become malignant spontaneously, if they are merely carried in culture for a prolonged period. To study the question, a cell line of whole mouse embryo fibroblasts from the nude mouse strain has been established. Although much work remains to be done, it is already clear that the cultures became malignant without acquiring any *in vitro* characteristics thought to reflect malignancy. Furthermore, it has been possible to detect malignancy much earlier with the sponge culture-implantation technique.

The nude blue mouse colony represents a way to pursue aspects of cancer research with experiments that could not be conducted a dozen years ago. They are used to eliminate natural impediments to tumor growth. However, there are other defenses that probably cause the mice to retain some resistance to tumor transplants. The role of "natural killer" lymphocytes, for instance, is still unresolved and immune mechanisms may enhance tumor growth in some cases.

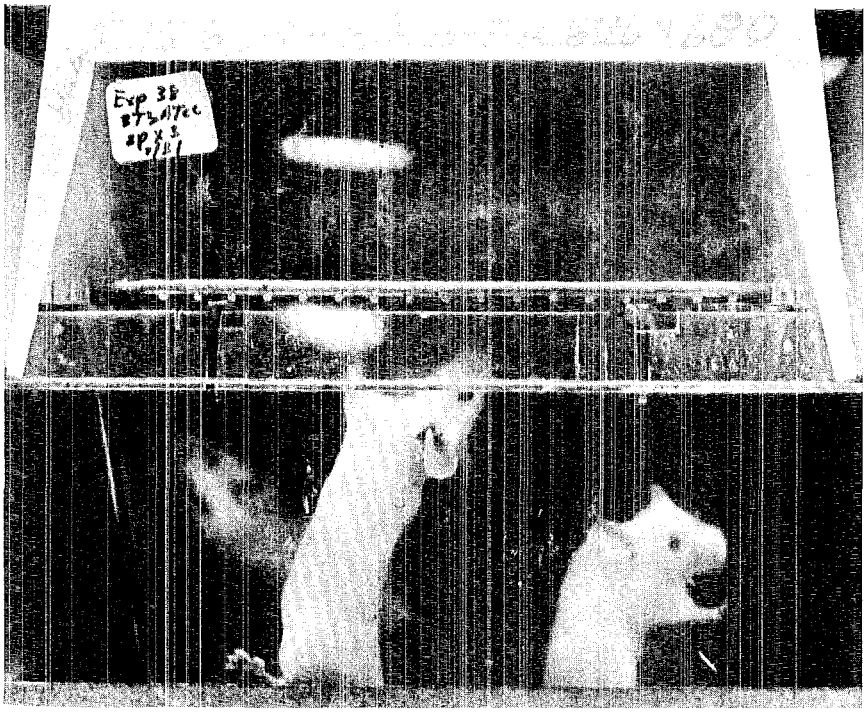
Between now and 1981, LASL experiments may shed light on some of these questions.



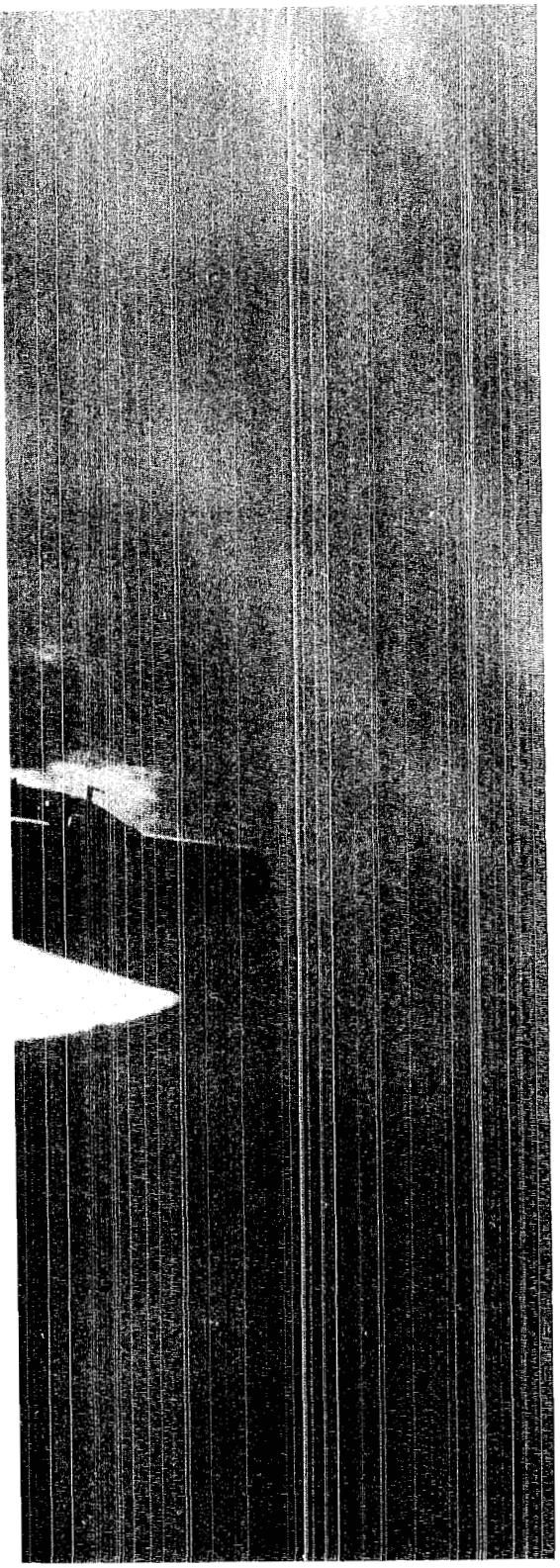


Through an incubator, Paul Kraemer and Mary Brooks are seen preparing to work with the colony, above. They remove special filtered tops of cages to gain access to the mice, left.

Trypan blue dye, a harmless agent, additionally blocks another host defense system. It engages the mouse's macrophages — a diversion.



LASL teammates for a decade



Flying high with the 58th: "A love affair."

Photos by Bill Regan

In 1948, Lt. Col. Paul H. Fackler mistakenly but successfully flew his airplane through a small segment of an atomic cloud. His experience led to an all-new Air Force squadron, whose chief aim is still carried on.

By Vic Hogsett

An apparent accident, turned sweet, formed the seed for new scientific techniques for sampling the atmosphere. It was 1948 when an Air Force lieutenant colonel mistakenly but successfully flew his airplane through a small segment of an atomic cloud during Operation Sandstone. Lt. Col. Paul H. Fackler may not have realized it at the time, but his experience was soon to give way to an all-new Air Force squadron whose chief aim is still carried on by NASA air crews for the Los Alamos Scientific Laboratory and others.

Three years later the same person, but now a full colonel, conceived the idea of forming an air sampling squadron. The Air Force liked the idea, but funds committed to the Korean War prohibited its immediate implementation. Finally, in 1953, Air Force headquarters approved the formation of a sampling squadron.

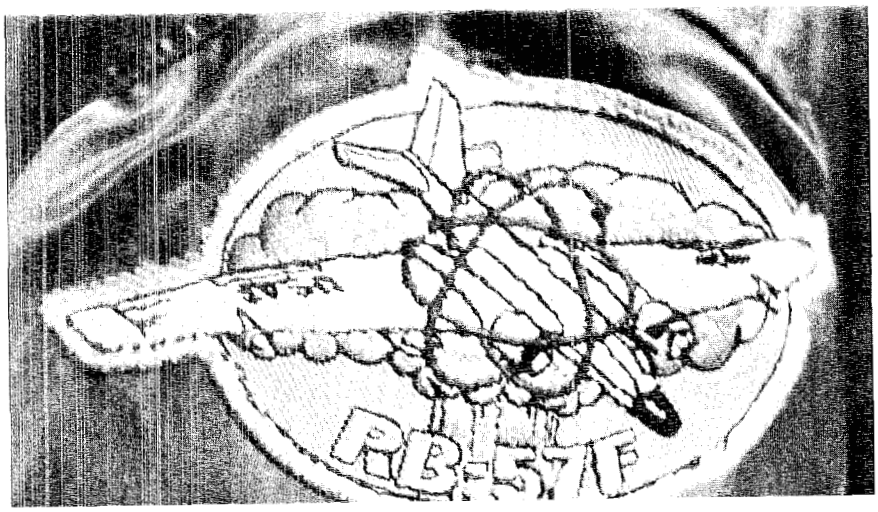
"To obtain samples"

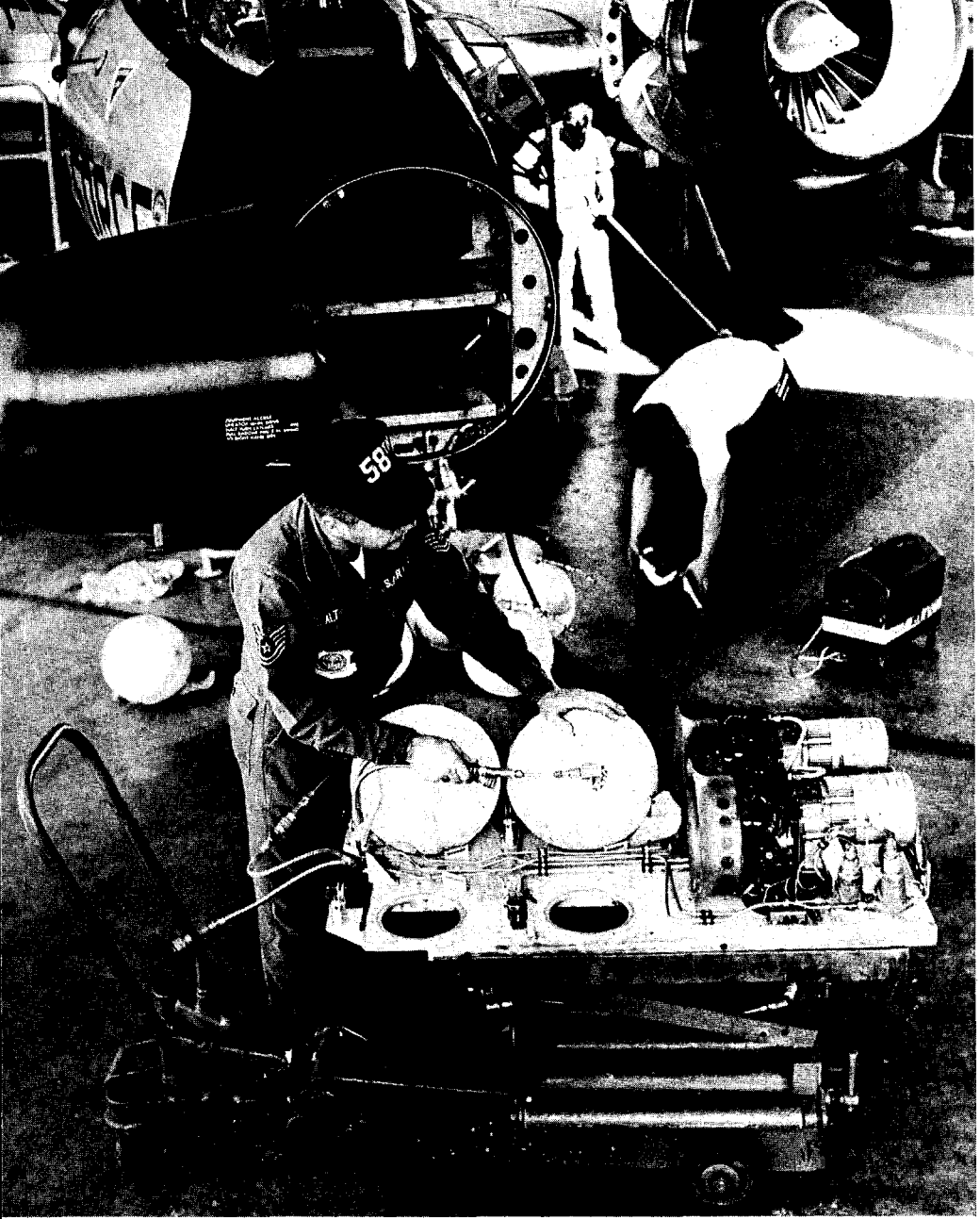
Though the name of the squadron changed several times over the years, it retained one stated purpose: "*to obtain samples of the* gaseous and particulate composition of the atmosphere and to accomplish weather, photographic, and other high-altitude research projects as dictated by the requirements of the United States Air Force, governmental, and civilian scientific organizations." Early in the game, the dictated requirements meant sampling air following atmospheric tests of nuclear devices.

Based at Kirtland Air Force Base in Albuquerque, the squadron was first known as the 4926th Test Squadron. In 1961 it became the 1211th Test Squadron (Sampling). It ended its life in 1974 as the 58th Weather Reconnaissance Squadron.

Just after the dawn of the nuclear era it became apparent that the collection of more complete data from nuclear detonations was of great importance to the men who designed the devices. Those concerned felt that one of the best sources for this additional information was the actual cloud which resulted from the nuclear blast. And the best means for gathering that information was with aircraft, specifically manned aircraft.

Because of the high levels of radioactivity contained in such clouds, officials were initially reluctant to send a manned aircraft into them. After much experimentation with B-17 drones, scientists decided that better information could be gathered with manned flights. Manned flights could provide more positive control and greater operational flexibility than was being found with drone aircraft and other sampling techniques.





Gaseous collection equipment was placed in a B-57 nose cone before an atmospheric sampling mission.

Several aircraft were first employed, but the plane for the job became the RB-57F, our version of a British design. It was maneuverable, and high-flying.

Several types of airplanes were employed including the B-29, the B-36, and 2 jet aircraft, the F-84 and T-33. The latter 2 were first used at the Nevada Test Site in 1952. However, scientists still thought better information could be obtained, particularly at higher altitudes.

A list of criteria was drawn up and it became obvious that the plane for the job was the U.S. version of a British-designed craft. It was called the B-57. Several versions of this airplane were used, but the final model proved the best; it was designated the RB-57F, and was actually a completely redesigned airplane built into an existing airframe. The aircraft had the speed and maneuverability to keep radiation exposures to the 2-man crew within safe levels.

Special job, special plane

Because a highly radioactive environment was involved, air sampling was governed by strict procedures that were carefully followed to ensure the safety of personnel and the successful completion of the mission.

The high-flying aircraft were equipped with a wide variety of specialized sampling equipment, radiation measuring instruments, and data recording devices, all of which were installed in or controlled from the navigator/observer's station in the cockpit. Three radiation measuring devices were used, including the cockpit rate meter, or Rascel. This meter is a self-contained unit that shows the radiation level in the cockpit at any instant. An integrating dosimeter, or integron, recorded the total or cumulative radiation exposure received in the cockpit. This instrument was the primary means for determining the length of time the aircraft could safely remain in a radioactive cloud to collect samples.

The wing tip ion chamber, coupled to a cockpit-mounted indicator, was a remote sensing unit located behind the air sampling pod on the right wing. A tuning-fork-controlled clock was used for the precise time reference required to synchronize sampling operations between planes and control ships. Other parameters were established via a multi-channel tape unit which recorded readings from the sampling instrumentation, the clock, voice communications, aircraft speed, and altitude.

Each aircraft was equipped with 2 types of sampling equipment, both LASL-designed. One was for the collection of gaseous samples and the other obtained solid particles from the air. Solid particles were collected by 2 precision filter units, one on each wing. The units

were of an aerodynamic shape designed to slow down air passing through it by a factor of 9 before passing through the filter paper. The design ensured that the efficient but delicate filter paper was not damaged by high-speed air moving through it.

The aircraft's nose section housed the unit for collecting gaseous samples. Included in the gas sampler were 8 wire-wound, high-pressure storage bottles and 4 compressors mounted on roll-out shelves. Gas samples, which could be gathered either through nose-mounted probes or through a bleed from the compressor section of the engine, passed through filter units to remove some of the radioactive fractions. The samples were then compressed for storage in the bottles.

LASL and the RB-57F

Pilots and navigators received a thorough briefing to familiarize them with details of the nuclear test being conducted and the plans for the air sampling mission. Many of these briefings came from men such as LASL's Paul Guthals, CNC-11 (Nuclear Chemistry Group). He was the scientific project manager from LASL for about 25 of the 58th's missions. He replaced LASL's Hal Plank in 1957 who was engaged in the same capacity. Guthals coordinated sample collection for later laboratory analysis. He is still involved in air sampling coordinated with NASA-flown B-57s and other high-flying aircraft.

Guthals and Plank represented LASL's air sampling interests in the nation's overall testing program. Lawrence Livermore Laboratory had similar counterparts for its role in the atmospheric testing days.

The scientific coordinators were experts on air sampling operations and were completely familiar with the nuclear experiments being conducted. Their knowledge and experience allowed them to accurately predict the conditions the sampling aircraft encountered during the mission.

All missions were conducted under the watchful eye of scientific advisors airborne on control aircraft. These men kept track of the

The squadron gathered data also on the impact on supersonic aircraft and on the damage to the ozone layer by fluorocarbons. B-57s still are used in Project Airstream to analyze air pollution sources.

Paul Guthals, who coordinated air sampling for LASL with the Air Force during atmospheric testing days, received assistance in donning his custom high-altitude suit before a 1968 flight.

It was felt the best source of information was the actual cloud from a nuclear blast, and the best means for gathering was with aircraft.

sampling aircraft and made sure the proper samples were collected in the shortest amount of time.

Once collected, the samples were taken back to the mission home base, carefully removed, and shipped as soon as possible to testing laboratories.

More than cloud duties

Though sampling atomic clouds was an important function and the the original impetus for, the 58th and its predecessor squadrons, it was also involved in other scientific endeavors, some of them ongoing.

Guthals said the squadron and LASL were active in a Department of Transportation-sponsored program interested in assessing the impact of supersonic aircraft, particularly the SST, on our environment. The study was completed in 1976, but furnished valuable data that is still in use by researchers throughout the country.

The squadron also gathered data, Guthals said, that initially suggested that the ozone layer of our upper atmosphere was being damaged by the introduction of fluorocarbons. He added that this study is ongoing and is being examined with closer scrutiny than ever before.

"There is still a very large interest in the ozone levels in the atmosphere," Guthals said. "We're looking for the net effect of any change." The ozone layer is responsible for shielding Earth's inhabitants from the harmful effects of ultra-violet radiation.

B-57s are still employed by LASL and the New York City-based Environmental Measurement Laboratory under a cooperative study sponsored by the Department of Energy. Called Project Airstream, the study is concerned with the collection and analysis of stratospheric particulate air samples, mostly from air pollution sources around the country. The study hopes to uncover the effects of dumping industrial, transportation, and other wastes into the atmosphere. The current project also monitors radioactivity from atmospheric nuclear testing performed by other countries, particularly China.

NASA offshoot still flies

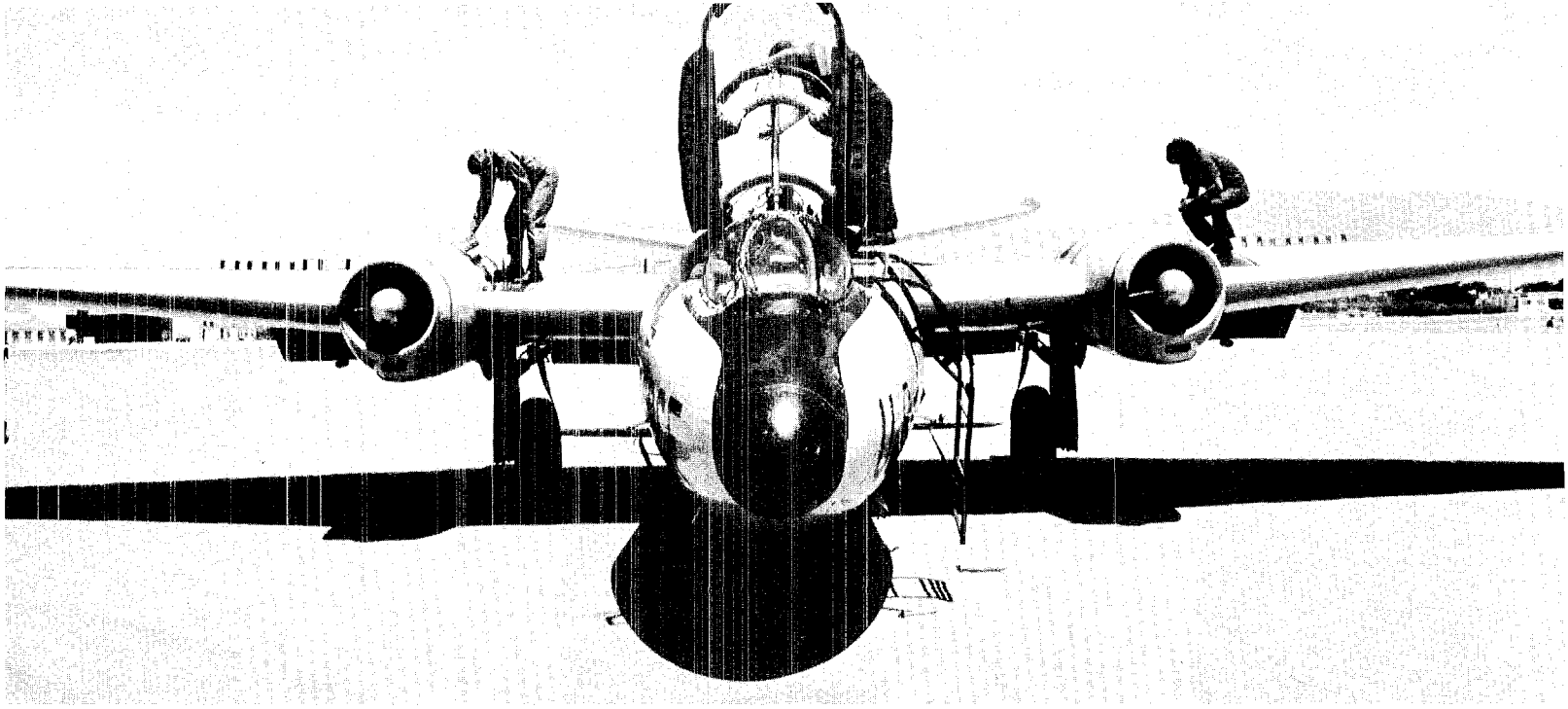
Guthals pointed out that these are a small fraction of the projects which the 58th was involved in prior to its deactivation. He said the squadron conducted various studies in all hemispheres throughout the world. He added that the NASA offshoot of the original 58th still conducts about 45 flights a year ranging from Panama to Alaska. Data acquired on these flights has proved invaluable for many researchers.

In addition to gathering samples, the planes must also establish environmental parameters such as longitude, latitude, altitude, aircraft speed, temperatures, pressures, etc. Guthals said the B-57 is best suited for studies of this nature because of its ability to fly at high altitudes, above 60,000 feet, at relatively slow speeds; mach 0.7 is top speed for the 2-man airplane. The plane can carry 4,000 pounds of scientific equipment and has a range of about 2,000 miles.

The 58th was based at Kirtland for the duration of its life. According to a squadron history, the group was originally designated the 4926th Test Squadron (Sampling). But, because of the moratorium on nuclear atmospheric testing of 1958, most of the successive missions were related to U.S. Weather Bureau projects. (Testing was resumed briefly in the early 1960s).

In 1961, as a result of their new duties, the squadron was placed under Headquarters 9th Weather Reconnaissance Group, Air Weather Service (MATS), with the new designation as the 1211th Test Squadron (Sampling). Less than 2 years later the 58th was born with no further changes in unit mission, and in 1974 the 58th was disbanded in formal ceremonies at Kirtland.

The squadron was born as the 4926th Test Squadron in 1953. It became the 1211th Test Squadron (Sampling) in 1961 and the 58th Weather Reconnaissance Squadron in 1963. It was deactivated in 1974.



Reunion for the 58th

This B-57 received one of its final maintenance checks in Albuquerque in August, on the last leg of its deactivation journey toward Arizona. Col. James Goodnight, here seen checking a cockpit, flew one of the 2 planes to Kirtland Air Force Base from Montana as part of a reunion.

About 100 members of the now-disbanded 58th Weather Reconnaissance Squadron and their spouses gathered in Albuquerque July 27 to witness the landing of 2 rarely seen B-57 jet airplanes at Kirtland Air Force Base, beginning a 3-day reunion. A third plane, which was to be flown by NASA for the Department of Energy, did not leave its home near Houston due to hurricane and flooding alerts. The two jets headed for Davis Monthan Air Force Base in Arizona for deactivation.

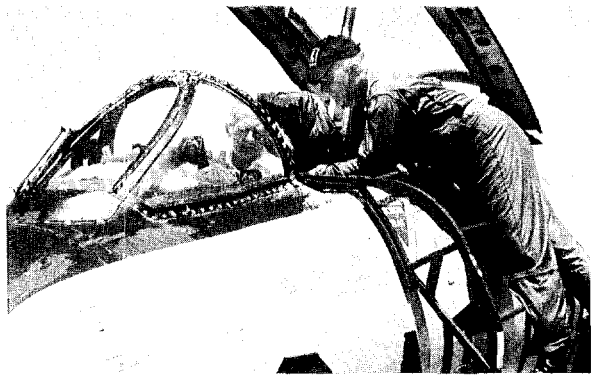
At its largest, the 58th Squadron consisted of 450 people and 18 aircraft. It flew in more than 35 operations sampling contents of atomic clouds and performing other scientific research tasks. The 58th had 2 other names earlier in its history.

One pilot recalled an emergency landing in an open field near Kirtland Air Force Base, due to an engine malfunction. Later it was discovered his jet tanks contained about 40 percent water. Fortunately, no such incident occurred on a long-range mission, he added.

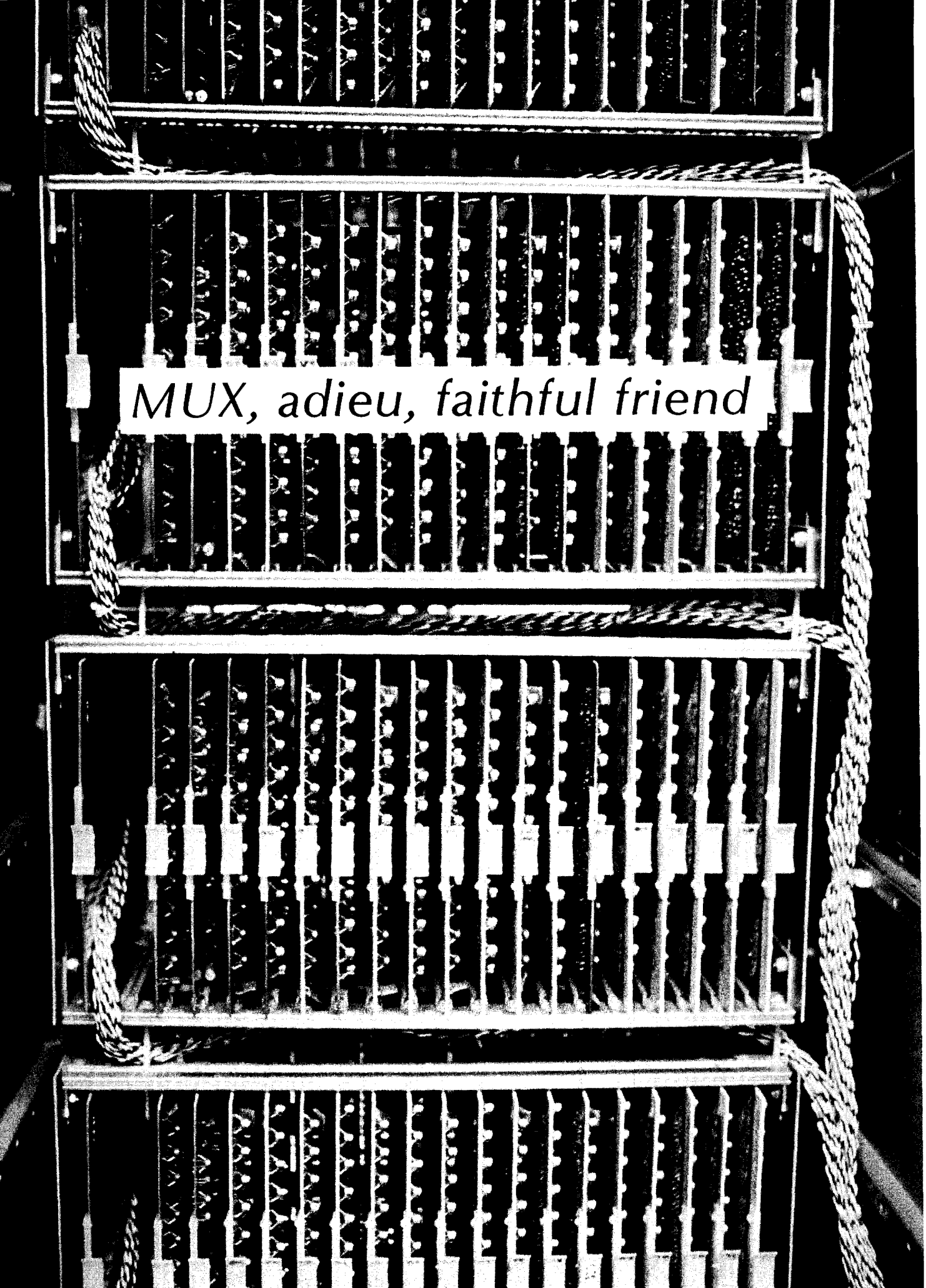
Colonel James Goodnight, who flew one of the B-57s from his home in Montana, had only praise for the jets. As a 58th Squadron member, he flew many of the jets in various scientific studies in several parts of the world. He described his relationship with the plane as a love affair, adding that it handles nicely and has plenty of power. He was one of the few reunioners that is still active in the Air Force.

Organized by Albuquerque's Margie Leonard and Gerri Reedy, the reunion gave old squadron members their first opportunity since deactivation to rehash the old days on Christmas Island; in Argentina; Indian Springs, Nevada; and other places throughout the world where the squadron conducted sampling missions.

Photos by Vic Hogsett



An ion chamber was a remote sensing unit located on the right wing tip. LASL-designed equipment sampled gaseous and solid particles.


MUX, adieu, faithful friend

MUX worked 24 hours a day, never got sick, took vacation or argued about pay raises. Nevertheless, MUX's age was showing.

An old friend left the Computer Science and Services (C) Division August 23, but not without proper ceremony, reminiscences, and a special goodbye cake.

In this case the retiree was an electronic apparatus known as MUX, an acronym for Multiple User Experiment. It operated faithfully since July 1968, and in recent years required service perhaps once a year. It never got sick, took vacation, or argued about pay raises. And MUX worked 24 hours a day.

But MUX simply could not handle current load requirements, and C-Division needed the space for other equipment. So its power supplies were ceremoniously turned off, and MUX was later removed from the Central Computing Facility (CCF).

MUX represented "wired logic," as opposed to its replacement, a PDP 11/20 computer, which can be programmed. MUX was designed and built right here, in a project undertaken by what is now C-Division and the Physics (P) Division. Its specifications were completed June 27, 1967, and it was constructed of components that used the first integrated circuit technology of the mid-1960s.

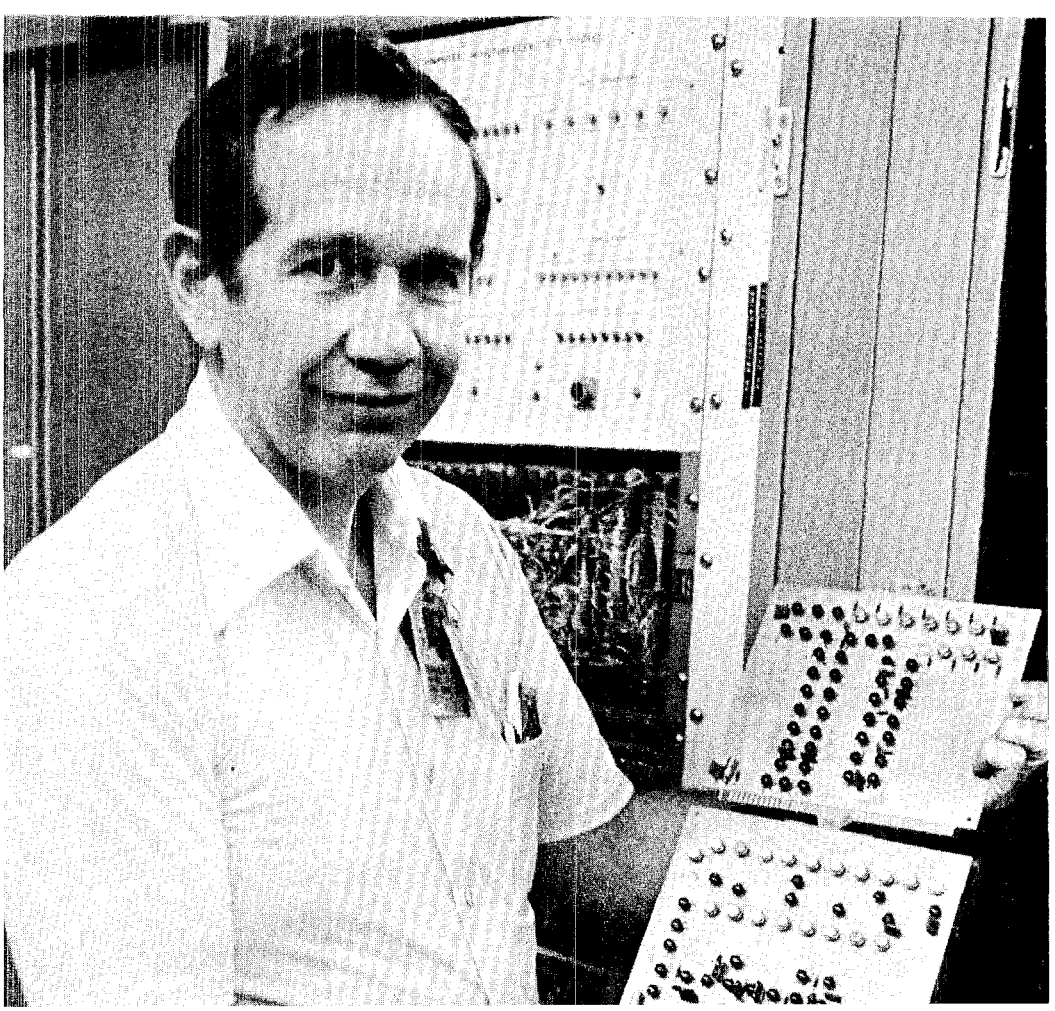
The purpose of this effort was to make possible an experiment in computer time-sharing. Back in 1967, recalled Jules Levin of Group C-9, there was a real debate whether time-sharing was the way of the future, since it was just starting nationally. The notion of computer services being delivered to one's work space, rather than the user going to the computer room, was "radical."

MUX was later used to provide computer access to visiting personnel and LASL employees who lacked security clearances and therefore were not permitted secure access to the CCF. Over the years, 320 badgeless persons were authorized to use the CCF via MUX; they included British, Canadian, French, German, and Japanese citizens in addition to U.S. citizens. Presently there are 119 authorizations for such computer access via MUX's replacement.

At the most, there were 75 computer terminals and 2 computers connected to the CCF through MUX. Computer access was first through private telephone lines, and later through a dial-up facility.

Nevertheless, MUX's age was showing.

"It was so reliable, we had to relearn how to fix it whenever something went wrong," Levin noted. "But after 11 years, we



The wired logic of MUX, seen in its more than 8,000 integrated circuits and 2 miles of twisted-pair cable, had become obsolete in today's world of circuit chips.

Photos by John Flower

Back in 1967, there was a real debate whether computer time-sharing was the way of the future. Could such a radical notion catch on?

constantly wondered when it would have a major failure." MUX's replacement enhances LASL control of computer access, since even persons without security clearances now have to identify themselves by means of private passwords.

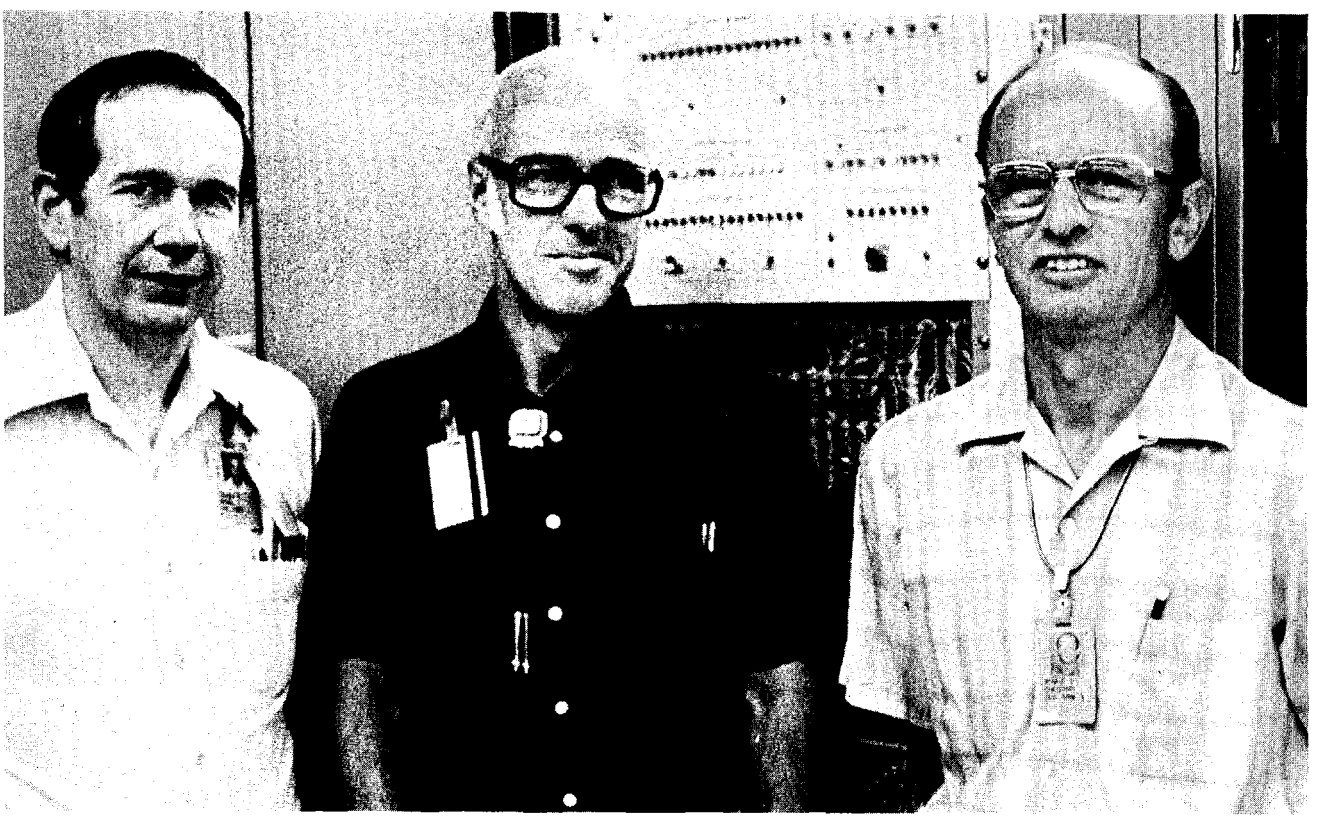
The replacement system was gradually brought on line over a 3-week period. After the passwords were put in the system the morning of August 23, the last of the MUX ports was deactivated and MUX was powered down.

MUX contained more than 200 circuit cards, the components of any one of which would now fit into a small circuit chip. MUX used more than 8,000 integrated circuits. It also contained more than 2 miles of twisted-pair wire, all of which was twisted with an electric drill.

Tom Gardiner was MUX's designer; Don Myers fabricated and assembled much of the electronics; and Ron Christman wrote the first software package. All were on hand to say goodbye.

"The experiment worked," Levin noted. "The replacement is designed from everything we learned from MUX."

— JLP



Original MUX team, from left: Don Myers, Tom Gardiner, Ron Christman. The experiment, it should be noted, was an 11-year success.

Thoughts on federal research and industry

(Editor's note: This article, written by a staff member from the office of Institutional Relations, is intended to be an informational tool for persons who deal with industry.)

By David A. Freiwald

"[Historical] evidence strongly indicates that large projects directly performed by government for the development of products and production process equipment are likely to be quickly made obsolete by the rapid pace of innovation in industry [once industry steps in], and their results have not found widespread use... But government performance of more basic research has evidently made outstanding contributions to industrial innovations..." ("Government and the Innovation Process," J. Herbert Holloman, *Technology Review*, May 1979.)

But we must note that a philosophical shift took place in the evolution from the Atomic Energy Commission (AEC) to the Energy Research and Development Administration (ERDA) in this decade, as a change was made in the federal agency in charge of national laboratories such as Los Alamos. The shift was toward more mission-oriented programs, namely for nearer-term "civilian" problems. This emphasis has been carried forth by the Department of Energy (DOE), which began its existence in 1977.

As a result, in the last few years national laboratories such as LASL initiated *applied* programs for which the main measure of success lies in the application of their results in the economy. This evolution toward more non-defense applied programs suggests the need for increased LASL/industry interactions to provide LASL with perspectives it does not have, to apprise industry of LASL's efforts, and to help guarantee success of mainstream programs by early involvement of industry as a partner.

With increased emphasis on *mission-oriented programs*, national labs should become more aware of, and sensitive to, industry counterparts:

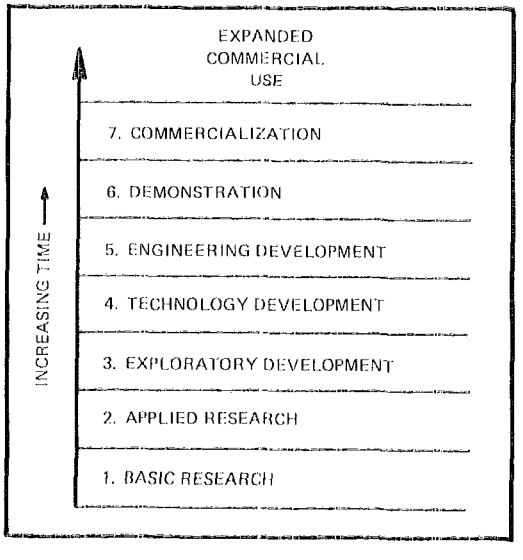
—The value of a federal research program can be greatly increased if the basic research may cause several dollars to be spent by non-governmental sources on applying and commercializing the products of the research.

—It is also desirable that federal research funds be directed toward fields in which private research is not already heavily engaged, such as expensive, long-range, or speculative R & D that is considered too high a risk by industry. Nonetheless, at some time through the process of moving "vertically" from basic research up into commercialization for successful projects, industry should be "brought on board" to assure smooth transitions with time.

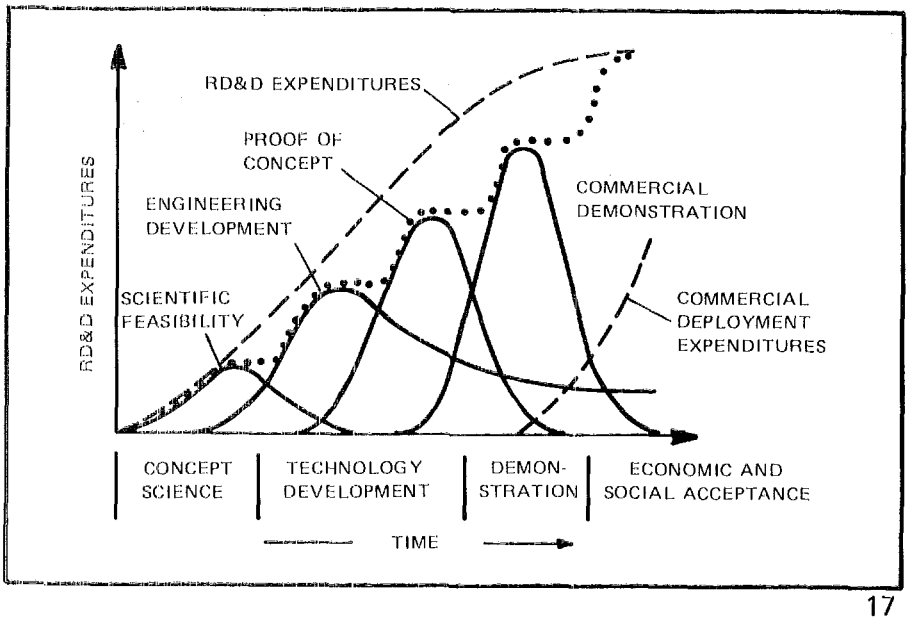
—Results from federal research may have *several* applications, of interest to several different industries and firms.

LASL is highly involved in concept science and technology development. Beyond those phases there are additional hills to climb, with concurrent increases in R & D expenditures, and also more

Successful R & D projects move through vertical levels, defined by the Department of Energy.



Typical R & D expenditures, and hills to climb, for a successful advanced concept.



scrutiny of programs vis-a-vis expenditures of public funds.

An approximate overall composite distribution of LASL's efforts vis-a-vis the 7 levels depicted here shows that LASL is highly peaked in what DOE refers to as Applied Research and Exploration Development work. Different *specific* programs at LASL may have more or less relative emphasis for the vertical levels and such emphasis changes as programs mature.

A composite profile of industry involvement would likely show relatively few funds in basic research, with funding increasing through the verified levels and becoming large in commercialization phases. For a specific project or industry, that curve may be shifted up or down, or have a slightly different shape. Even for the same project, different specific industries may have different involvement profiles, depending on their own risk/benefit analysis, resources available, relative priorities for stockholder dividends versus R & D, and so forth.

There is a high mortality region in moving up through the 7 vertical levels. In that region, many ideas or potential concepts are rapidly deleted for engineering, economic, environmental, or other reasons. Most of LASL's work is in that high mortality region, which leads to 2 general observations:

1. As suggested above, one role of the national labs is to explore fields considered too long-range or speculative by industry.
2. With increased DOE emphasis or mission-oriented work, it is desirable to reduce the number of casualties in the high mortality region.

To help assure transitions towards commercialization and to reduce the mortality rate, the challenges for both LASL and industry are obvious:

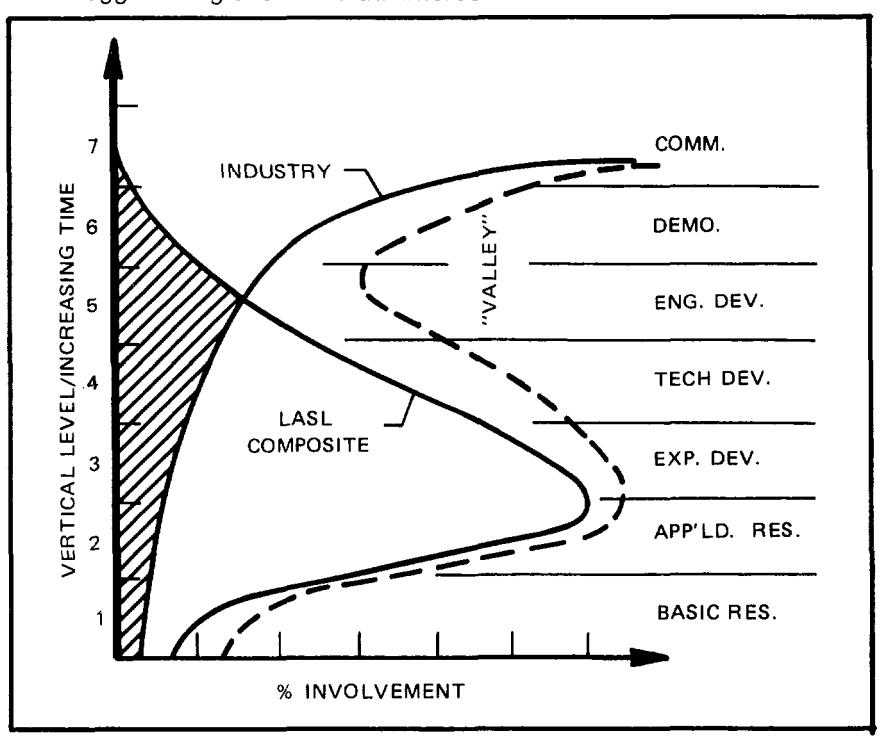
—Begin interactions perhaps as early as the applied research phase. It has been suggested that up to 5 per cent of R & D funds be spent beginning in applied research phases to start work on systems analysis and engineering / economic trade-off studies, with a view toward system integration, operation and reliability, and economics (capital, operating, maintenance, decommissioning) vis-a-vis competing technologies, supply/demand, market penetration and risk/benefit. If scientists try to interest a utility (example, ultimate customer) in an emerging technology to gain "industry support," one of the first things that they will want to see is the results of such trade-off studies; that's what their stockholders, regulatory commissions, and the financial community will eventually want to see. LASL's new S-Division and Office of Planning and Analysis were created to, in part, be of help in such analysis. Also involving industry in such studies can be beneficial.

—Maintain and expand those interactions through time for successful projects, noting that interactions may aid in the success. Some projects may fail because of *lack* of interactions, and some projects may be justifiably terminated.

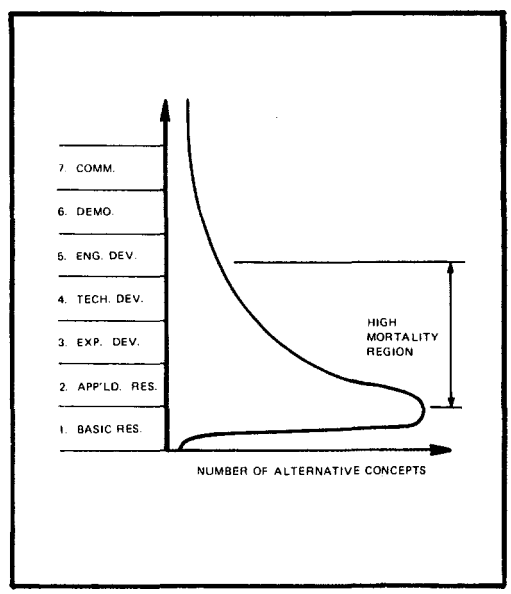
—Explore, together, regions of mutual interest to see if and how involvement profiles can or should change to increase overlap.

—Interact with the ultimate consumer (e.g., a utility) and those industries that manufacture equipment used for (bought by) commercial operations.

Approximate R & D involvement profiles for LASL and industry. The shaded area suggests regions of mutual interest.



Conceptual mortality for advanced alternative concepts is highest in the beginning levels of development.

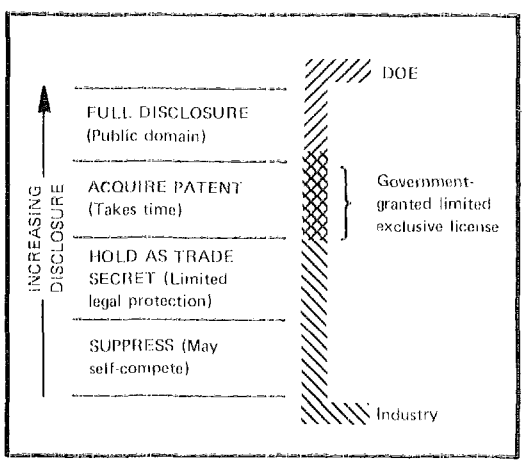


Early feedback on industry perspective can be most helpful. It's a decision on industry's part as to what level (time) that they want to get involved; this is partly influenced by perceived institutional barriers that include such things as DOE patent policies and industry proprietary information policies.

We must keep in mind that private industry is "... rarely willing to put their own capital and research efforts into a product without being able to protect their investment. Another company could simply license the same technology, copy the adaptive techniques employed by the first company, and then invade the market at great advantage. Without having to amortize the costs of final development necessary to bring the invention to practical application, the second company could significantly underprice the first company... to hurdle this barrier to technology transfer, the government now permits limited exclusive licensing. This new policy became effective in Feburary 1973..." ("Patents: Impediment or Expedient to Technology Transfer," T.E. Elsasser, "Journal of Technology Transfer," 1(2), 1977). Such licenses are obtained through a process of negotiations.

To help in fostering a climate of cooperation with industry, LASL's new office of Institutional Relations is preparing a booklet entitled "Opportunities for LASL/Industry Cooperation" that describes mechanism for interactions. This should be available shortly, and will be distributed to all LASL staff members as well as to industry.

Types of R & D information disclosure.



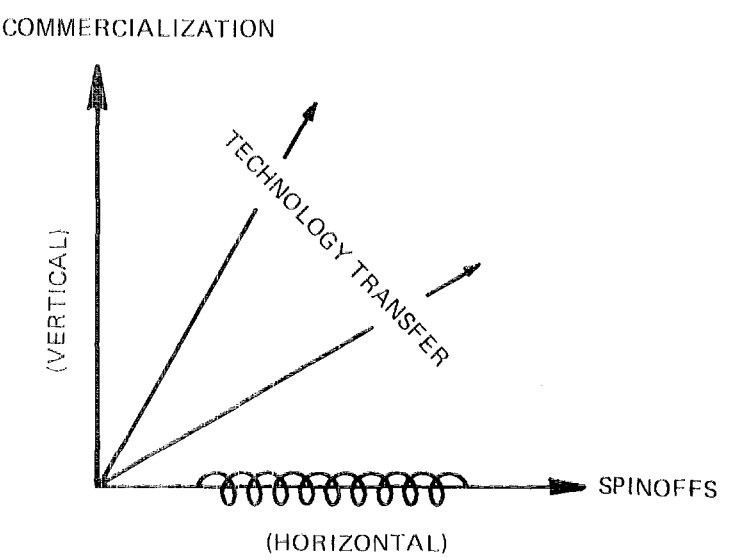
Various terms have been used by different people to describe the movement of results of federally funded research into private industry. Here, for the sake of discussion, we use the following terms, where attention is addressed to the meaning or "flavor" of the vector rather than exact words:

Technology Liaison (TL): catch-all term combining commercialization, technology transfer, and spinoffs, i.e., anything on the "map," with "Liaison" as an action word.

Commercialization: moving a mainstream DOE program vertically, i.e., from basic research through applied research, development engineering, demonstration,on, etc., into commercial operation.

Technology Transfer: almost anything from nearly vertical to nearly horizontal transfer, such as turning over to industry special instrument designs, computer codes, etc., that they may use in a program of theirs that is parallel to, or a branch of, a DOE vertical program.

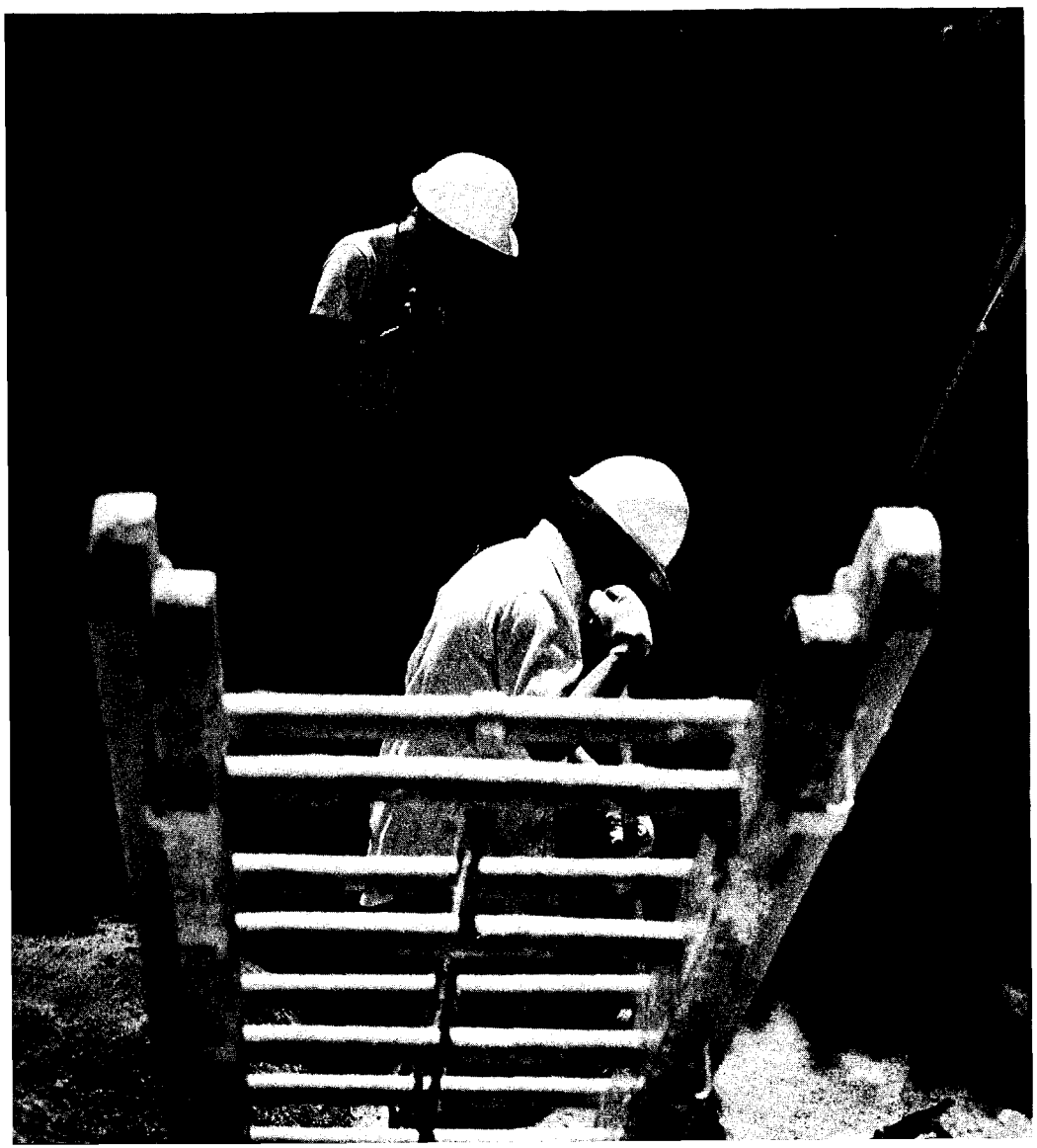
Spinoffs: generally horizontal transfer and utilization of information or techniques that firms may use in programs of their own that may be unrelated to DOE vertical programs.



Technology liaison vectors.

A large kiva near the Accelerator Technology building raises questions. Four rooms were built nearby first, then the kiva, then a garden area.

A kiva is excavated — this time with metal tools



Not far from the parking lot of the Accelerator Technology (AT) Division, the remains of a Pajarito Plateau Indian kiva, or ceremonial room, have been excavated. Like other sites near Los Alamos, this one brings questions to the mind of LASL archeologist Charlie Steen.

There are 4 small rooms of unknown use nearby that were built before the kiva. Pottery sherds from the site predate the kiva by about 100 years.

The site was first surveyed in 1957 by former LASL archeologist Fred Worman. "There was a mound through the trees," said Steen, "and I thought it was a pueblo and plaza arrangement, with a kiva in the swale. A tunnel is being planned near here from the Weapons Neutron Facility, not through the site itself, but we decided last fall to start digging, to avoid damage to the site."

In July, Zia workers removed the last earth from a hard-packed floor

The kiva near LASL's AT-Division offices is a large one, about 15 feet across and 8 feet deep. It was cut into the rock by pounding the tuff into fragments with stone tools.

Photos By John Flower

stained with charcoal and body sweat, and excavated the firepit and the ventilator.

The kiva is a large one, about 15 feet across, and most certainly was used for religious and ceremonial purposes. There are 2 other known isolated kivas on the Pajarito Plateau, one east of TA-36 and one near TA-49. The kiva was literally dug into the soft tuff rock, which has eroded slightly around the edges. The Indians used no spades, but hacked at the rock with stone tools, perhaps made from Pedernal chert. "They just pounded it to death," said Steen. A part of a stone club head and a part of a grinding slab for bone and wood tools have been found at the kiva. There is no evidence of viga poles for the roof, but a rectangular cut in the stone could have supported a viga end. There is no evidence of a burned roof, but inhabitants usually took roof poles with them when they moved on.

The 4 small rooms nearby have no fire pits, and were constructed probably in the late 1200s; the date is based on pottery sherds taken from them. The pottery is all of the type called Santa Fe Black on White.

The kiva, however, was not introduced into Pajarito culture until about 100 years later, in the late 1300s. There is no evidence, further, that the rooms were inhabited when the kiva was in use.

Nearby is a series of rock alignments, used as garden borders for dry farming to help collect and divert rainwater to crops.

About 5 feet down inside the kiva, which was filled with earth over the years, Steen and the crew found Abiquiu Black on Grey pottery, very thick, mostly large bowls used for food storage.

"What we have here," said Steen, "is a 4-room building of unknown use. Long after it was abandoned, someone built the kiva. The garden area was later yet, and it was the kiva excavation that left the slight mound around the site."

As the crew worked down to the kiva floor, about 8 feet below the ground, eyes looked for pottery sherds or a glint of other manmade

Zia workers excavated down to the hard-packed floor, looking for pottery sherds and other archeological artifacts.

Nearby are 4 small rooms of unknown use that were built before the kiva.

materials as trowels turned small amounts of earth.

"One always hopes for something like a foot drum," said Steen, "but I think we'll just find a plain floor, and a good firepit and ventilator to one side."

Mud floors were laid by the Indian inhabitants with a stiff clay. While it was drying, women (presumably) rubbed the surface quickly and hard with a smooth river pebble, floating a hard surface that would last a long time. When repairs were required, the area would be dampened, mortared, and the stone used again.

So far, no ornate jewelry, such as the turquoise necklaces found at Chaco Canyon National Monument, have been found on the Pajarito Plateau. To persons more delighted with gold masks and many-storied temples, the discovery of pottery sherds and a few broken tools may seem meager.

To Steen, it makes his work more fascinating. "We haven't ever found any turquoise, although a lot of it was shipped out from around here," he said. "They were constantly on the go. Sometimes they lived in one spot as little as 6 months. A generation living at one site was probably rare. When they left, they swept the floors clean. If we find beads, they would be with a burial.

"These people were the first cousins of those who mined turquoise. Recently we learned that some of the turquoise found in Mexico and Chaco Canyon came from Los Cerrillos, southwest of Santa Fe. They were part of a trade system."

Turquoise is not found with Pajarito burials before about A.D. 1400. Then, customs had changed and people lived in the large pueblo-towns. Extensive mounds contained hundreds of bodies and pots in places.

Early this century, the Museum of New Mexico excavated all the large burial mounds, but a documentary report was never printed, so today's archeologists have little knowledge of them.

Frequently a small seashell or turquoise bit was inserted inside a firepit and was sealed over with adobe mud, said Steen. At the LASL kiva, no such offering was found, but the firepit itself is "beautiful," over a foot deep, and has almost vertical sides instead of the normally encountered bowl shape, said Steen.

Some of the artifacts found in the kiva, he continued, came from the dwellings to the east. People usually lived outdoors as much as possible, and on their rooftops rather than inside the adobe rooms. Litter in the kiva probably was washed in from the debris that earlier was thrown from the rooftops.

Precise dating of the kiva should come in about 6 months from laboratory results at the University of Oklahoma at Norman. Half a dozen small samples of earth and charcoal, each about a 2-inch cube, are being analyzed there with the new archeomagnetic dating technique.

The samples were taken by Tom Windes, of the National Park Service's Chaco Center, which is com-

"These people were the first cousins of those who mined turquoise. They were part of a trade system." The gem is sometimes found with burials dating from about A.D. 1400 onward.

Tom Windes of the National Park Service took samples from the firepit area for archeomagnetic dating tests, to be run at the University of Oklahoma at Norman. Iron bits were set into clay in alignment with the earth's magnetic fields hundreds of years ago in the firepit.

pleting a 5-year study to determine the influence of the Chaco Canyon puebloans had in the Southwest. The work is in conjunction with Steen's excavation and is said to be the most reliable dating method known, within 5 years of the actual date.

The earth's magnetic fields continually shift. At the kiva firepit, iron bits were set in clay walls in alignment with the earth's fields when fires were lit. The earth and charcoal samples will be compared against the present day magnetic orientation to ascertain a date.

The archeomagnetic date can then be compared to the dates given to pottery shards on the site.

— Jeff Pederson

10, 15, 20 years ago

20 years ago

Electron beam space gun

An "electron beam space gun," weighing less than a pound and powered by the sun, has been devised by physicist Richard J. Watts of Group GMX-11. It can efficiently weld light weight metals in the vacuum of space. Watts suggests that parts of prefabricated space stations could be assembled in space with his welder after being sent up in a space vehicle. The gun would use about as much power as a 100 watt light bulb. It is designed to hurl electrons at 15,000 miles per second at materials like aluminum and magnesium.

Explosion kills 4 men

Three outside experts arrived at Los Alamos this week to assist in an investigation following the accidental detonation of high explosives at S-Site last week. Four Laboratory employees were killed in the October 14 blast, which occurred near a truck at a waste burning pit as the men were unloading scrap before a routine burning operation. There have been no previous explosions of this type here. The 4 men: Jose Cordova, Sevedeo Lujan, Escolastico Martinez, and Leopoldo Pacheco, all of Group GMX-3.

Largest power storage supply

One of the world's largest energy storage capacitor banks is being installed in the Project Sherwood building. Called Zeus after the ancient god of the elements, the bank will deliver 40 million amperes in 10 microseconds.

15 years ago

The diagnostic air force

About 3 dozen staff members and technicians are taking part in readiness exercises, without nuclear explosions, scheduled between mid-October and early November in the Johnston Island area of the Pacific. The exercises are to check out one of the safeguards outlined to the Senate by the AEC and the Department of Defense; it involves the "diagnostic air force" of 3 planes. One is assigned to LASL, the others to Sandia Corporation and Lawrence Radiation Laboratory. All are based at Kirtland Air Force Base in Albuquerque.

County's wild side

The back country hiking routes are by-products of a forest and wildlife conservation program being carried out in the wild and rugged north end of the county. Conservation Officer Homer Pickens is directing the work, which includes roads, trails, signs, check dams, reseeding and reforestation. The project is by the local AEC office. Heretofore inaccessible parts of the county are being made reachable by fire fighting equipment to stop forest blazes in their infancy. Many foot and horse trails have also been restored. There are signposts at key intersections.

Computers in the plumbing

James H. Griffin has written a new computer program that permits a full analysis of stress for complex piping systems. The importance of leakproof pipes in reactors was the reason for the work. No existing computer codes in the country were available to do the job.

10 years ago

Project Rulison in Colorado

The first major entry by LASL into the Plowshare program, designed to stimulate natural gas production, was marked Sept. 10 when a nuclear explosive was successfully detonated in western Colorado. Rulison is to provide data relating to the feasibility of using underground nuclear explosions in low productivity gas formations. The shot was 40 kilotons, at a depth of 8,430 feet. For the first time ever, the device was exploded manually in lieu of an electronic timing system. The red button used is slated for the LASL science museum together with a larger exhibit.

Californium-252

A group of scientists in Group N-6, safeguards, recently began a series of tests to determine whether an isotope could be used as a neutron source for non-destructive assay of nuclear materials. The isotope, californium-252, is available only in limited quantities. LASL received about a milligram. It was delivered in a 6 by 11 foot shipping container which weighed nearly 12 tons. It is an extremely intense source of neutrons.

The comprehensive plan

The county adopted a comprehensive plan and zoning ordinance in the summer of 1964. Five years later, a look shows it is geared to a maximum population of 30,800, for 1985, based on high growth. For 1980, a population of about 27,000 could result.

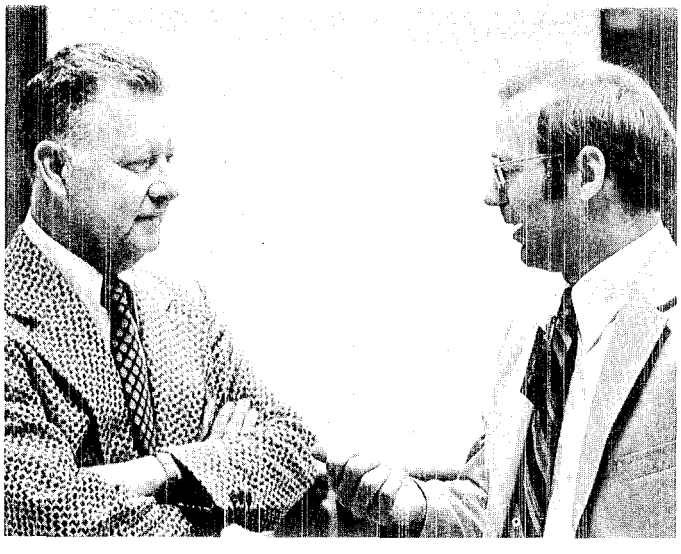
Compiled from past issues of *The Atom* and the *LASL News*.

Among our visitors

Gerald Brown presented a colloquium here on new directions in intermediate energy nuclear physics. Brown, who has authored 2 recent books, heads the Institute for Theoretical Physics at the State University of New York at Stony Brook. He is also a professor at the Nordic Institute for Theoretical Atomic Physics in Copenhagen.

Photos by Bill Jack Rodgers

David L. Olson, a staff assistant with the House Appropriations Subcommitee on Energy and Water Development, visited with Associate Director Richard D. Baker during an orientation here. Olson was joined by 2 persons from the DOE's Albuquerque Operations Office.



Brig. Gen. Niles Fulwyler recently came here for get-acquainted sessions and to discuss Army weapons programs. Fulwyler took over a new post as deputy chief of staff, operations, in August. He spoke with Director Donald Kerr during his stay.

Henry Wain and Keith Gibbs, both from the Material Research Laboratories in Melbourne, Australia, spoke with Ed Chapin, leader of the Systems Analysis Group (WPC-2) during a 2-day stay in Los Alamos.

Photo by Bill Jack Rodgers

U.S. Sen. Harrison "Jack" Schmitt took time to press the flesh during a visit to Group WX-4's facilities at Los Alamos.